

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:  
a semiconductor region including silicon; and  
a dielectric film including silicon, oxygen,  
5 nitrogen, and helium, the dielectric film provided on  
the semiconductor region, and the dielectric film  
having a concentration distribution with respect to a  
film thickness direction, the concentration distribu-  
tion having a maximal value of concentration of the  
10 helium in a surface portion on the semiconductor region  
side and a maximal value of concentration of the  
nitrogen in a surface portion on a side opposite to the  
semiconductor region.
2. A semiconductor device comprising:  
15 a semiconductor region including silicon; and  
a dielectric film including silicon, oxygen, and  
nitrogen, the dielectric film provided on the semi-  
conductor region, and the dielectric film having a  
concentration distribution with respect to a film  
20 thickness direction, the concentration distribution  
having first maximal value of concentration of the  
nitrogen in a surface portion on the semiconductor  
region side and second maximal value of concentration  
of the nitrogen in a surface portion on a side opposite  
25 to the semiconductor region.
3. The semiconductor device according to claim 2,  
wherein the maximal value of the first nitrogen

concentration is smaller than that of the second nitrogen concentration.

4. The semiconductor device according to claim 1, wherein the insulating film is a capacitor insulating film or gate insulating film.

5. The semiconductor device according to claim 2, wherein the insulating film is a capacitor insulating film or gate insulating film.

6. The semiconductor device according to claim 3, wherein the insulating film is a capacitor insulating film or gate insulating film.

7. The semiconductor device according to claim 1, wherein the semiconductor region is a silicon substrate, SOI substrate, or SiGe substrate.

8. The semiconductor device according to claim 2, wherein the semiconductor region is a silicon substrate, SOI substrate, or SiGe substrate.

9. The semiconductor device according to claim 3, wherein the semiconductor region is a silicon substrate, SOI substrate, or SiGe substrate.

10. A method of manufacturing a semiconductor device comprising:

forming a silicon oxide film on a semiconductor region including silicon;

heating the semiconductor region and silicon oxide film in a helium gas atmosphere; and

forming a insulating film including silicon,

oxygen, nitrogen, and helium by nitriding the silicon oxide film.

11. The method of manufacturing the semiconductor device according to claim 10, wherein heating the  
5 semiconductor region and the silicon oxide film in the helium atmosphere is performed so that helium is introduced into an interface portion between the semiconductor region and the silicon oxide film.

12. A method of manufacturing a semiconductor  
10 device comprising:

forming a silicon oxide film on a semiconductor region including silicon; and

forming an insulating film including silicon,  
oxygen, and nitrogen by nitriding the silicon oxide  
15 film and changing a film forming condition at least once in the course of formation of the insulating film.

13. The method of manufacturing the semiconductor device according to claim 15, wherein changing the film forming condition at least once in the course of  
20 formation of the insulating film is performed so that nitrogen is introduced into an interface portion between the semiconductor region and the silicon oxide film and into a surface portion of the silicon oxide film on a side opposite to the interface portion.

25 14. The method of manufacturing the semiconductor device according to claim 10, wherein the silicon oxide film is nitrided by a plasma of a material including

nitrogen.

15        15. The method of manufacturing the semiconductor device according to claim 12, wherein the silicon oxide film is nitrided by a plasma of a material including material.

10        16. The method of manufacturing the semiconductor device according to claim 12, wherein the semiconductor region and the silicon oxide film are laid on a holding electrode in a vacuum chamber in which a gas of a material including nitrogen and an inert gas are introduced, the silicon oxide film is nitrided by the a plasma of the material including the nitrogen, and the film forming condition is at least one of a pressure in the vacuum chamber, excitation power for generating the plasma, temperature of the holding electrode, bias voltage applied to the holding electrode, and flow rate ratio of the gas of the material including the nitrogen and the inert gas.

20        17. The method of manufacturing the semiconductor device according to claim 10, wherein a film thickness of the silicon oxide film is not more than 2.5 nm.

18. The method of manufacturing the semiconductor device according to claim 12, wherein a film thickness of the silicon oxide film is not more than 2.5 nm.

25        19. The method of manufacturing the semiconductor device according to claim 10, wherein a film thickness of the silicon oxide film is not more than 1.4 nm.

20. The method of manufacturing the semiconductor device according to claim 12, wherein a film thickness of the silicon oxide film is not more 1.4 nm.